1909

APRIL 1909 Botanical Series Vol. II, No. 8

IMPERIAL MYCOLOGIST
Regr:.....
1. Jan 07
PUSA.
IMPERIAL BUREAU
28 JUN 1921
OF MYCOLOGY

# Memoirs of the Department of Agriculture in India

## THE MULBERRY DISEASE CAUSED BY CORYNEUM MORI NOM. IN KASHMIR, WITH NOTES ON OTHER MULBERRY DISEASES

BY

E. J. BUTLER, M.B., F.L.S

*Imperial Mycologist*

AGRICULTURAL RESEARCH INSTITUTE, PUSA

PUBLISHED FOR
THE IMPERIAL DEPARTMENT OF AGRICULTURE IN INDIA

BY
THACKER, SPINK & CO., CALCUTTA
W. THACKER & CO., 2, CREED LANE, LONDON

Price Re. 1-8

21-X-15.

*APRIL 1909.* BOTANICAL SERIES. VOL. II, NO. 8

# MEMOIRS OF THE DEPARTMENT OF AGRICULTURE IN INDIA

## THE MULBERRY DISEASE CAUSED BY CORYNEUM MORI NOM. IN KASHMIR WITH NOTES ON OTHER MULBERRY DISEASES

BY

E. J. BUTLER, M.B., F.L.S

*Imperial Mycologist*

AGRICULTURAL RESEARCH INSTITUTE, PUSA

PUBLISHED FOR
THE IMPERIAL DEPARTMENT OF AGRICULTURE IN INDIA

BY

THACKER, SPINK & CO., CALCUTTA
W. THACKER & CO., 2, CREED LANE, LONDON

CALCUTTA :

PRINTED BY THACKER, SPINK AND CO.

# THE MULBERRY DISEASE CAUSED BY CORYNEUM MORI NOM. IN KASHMIR, WITH NOTES ON OTHER MULBERRY DISEASES.

By E. J. BUTLER, M.B., F.L.S.,

*Imperial Mycologist.*

## The Twig Disease of Mulberry.

(*Coryneum Mori* Nomura.)

The disease caused by this parasite is probably of long standing in Kashmir. It definitely attracted notice for the first time in 1906, when there was a severe outbreak in the State mulberry nurseries, near Srinagar. Previously there is no record of losses in the mulberries from disease, but it is quite possible that earlier outbreaks would have escaped attention, and there is nothing to indicate that the disease is a new one. In the two years since 1906, the damage has been slight in the nurseries ; probably the climatic conditions which favoured attack on the young trees have not since been repeated. Outside India the disease is only known in Japan, whence it was described for the first time, and the fungus named by Nomura* in 1904.

Nursery stock is not alone affected. It is fairly prevalent on full grown trees of all ages in different parts of the Valley, and must be responsible for a considerable reduction in the output of leaves.

---

* Nomura, H. Intorno alla ruggine del Rengeso (Astragalus sinicus L.) e a due micromiceti patogeni del Gelso (Atti Istit. Bot. Univ. Pavia, n. ser., Vol. IX, 1904, pp. 13-14).

3738

The parasite attacks the smaller branches, usually near the base. It is rare on those over an inch in diameter and is localized, extending only from one to three inches along the branch. At first it is usually confined to one side, but it always eventually affects the whole circumference of the attacked portion. Externally it is visible by the bursting out of a number of hard black cushions of fungus tissue, through angular cracks in the bark (Plate I, fig. 1). The whole of the affected area is slightly depressed and darker than healthy portions of the branch. The branch is killed above the attack, but internal spread backwards to healthy parts of the tree does not occur. The disease is thus truly local, attacking and killing individual branches only ; where the attacks are multiplied, the whole tree naturally suffers through insufficient nourishment. Some old trees were seen, much stunted, covered with dead branches, and bearing leaf only on feeble shoots arising directly from the trunk or older wood ; it is possible that these may be eventually killed, but no case where death resulted was seen. In the young nursery stock the attack may occur on the main stem near the ground level. In the outbreak of 1906, seedlings of the second and subsequent years were attacked and had to be cut back right to the ground in many cases. They then for the most part threw up healthy shoots from below. The young tree in the foreground of the photograph, reproduced in Plate I, fig. 2, was affected at the base of the leading shoot, just above a large pruned-off branch. This position near a cut branch or above a fork is very common and a possible explanation will be given below. Old trees are usually attacked in the young shoots of the current year's growth, which arise immediately below branches broken off during the silk-worm rearing season in April.

The fungus is not confined to living mulberry trees, but is also found on dead prunings and broken off branches on the ground. On these it may cover the whole of the branch, instead of a small part, as on living trees. It would thus appear to grow more freely within dead than within living tissues. Many parasites have this character, but are none the less destructive to living plants when they come into contact with them.

It has already been mentioned that the seat of attack is usually near the ground or above a fork in seedlings, and near the scars left in breaking off branches in older trees. The outbreak in 1906 followed a heavy fall of snow in the early spring ; this partly thawed and was succeeded by frost. The result was, as pointed out by Monsieur Peychaud, Director of Horticulture, Kashmir, that the seedlings were nipped near the ground and above the larger forks where snow had collected, and the bark was injured. The attacks in the older trees are always near a wound. The branch shown in Plate I, fig. 3, which is one of many such seen, shows a patch of infection around every scar left by removing the leaf-bearing side twigs during the plucking season. These facts all point unmistakably to the fungus being one of the large class known as "wound parasites" common in woody plants. Such parasites, as the name implies, attack their victims only through wounds, not through the unbroken surface of the plant. Anything which injures the surface—not only pieces broken or cut off but the holes made by insects and the bruises caused by hail or ice—may be sufficient to allow of penetration.

The wound parasitic fungi are found most commonly on dead wood. Ordinarily they are unable to grow through the cork which forms the protective bark of living trees. If this be cut away and the wood below exposed, many of them can then penetrate and exist by consuming the living tissues of the tree. Even in these cases, however, entry is much facilitated by the wound having been made in such a manner as to kill a portion of the wood as well as removing the bark. The fungus grows for a time on the dead wood around the wound, and having accumulated a store of nourishment, gains vigour enough to enable it to attack the living tissues beyond. Hence, while all wounds that are sufficiently deep may admit a parasite of this nature, wounds which are not clean-cut, but are jagged and leave splinters of dead wood attached to the tree, do so much more freely.

A careful search for *Coryneum Mori* on other plants led to its discovery on a rough-leaved jungle tree, *Celtis caucasica* (Kash. *Brimij*). It produces an exactly similar disease to that on

mulberry. The tree is not uncommon in the cultivated parts of the Valley, but is not likely to play much part in disseminating the disease.

## Description of the parasite.

The body of the parasite, as of fungi generally, is composed of numerous branching threads. These penetrate throughout the tissues of the attacked portion of the branch, where they are naturally hidden from view; they can only be seen on examining microscopically very thin sections of the wood, such as that, a portion of which is shown in Plate II, fig. 2. The examination of such sections shows that every part of the branch-tissues becomes infected, pith, wood, bast and bark. Towards the centre of the branch the threads are mostly colourless, while nearer the surface they are deep brown. They vary greatly in size, from large thick-walled brown threads, such as those in the large vessel of the wood to the left in fig. 2, to fine colourless ones in the small cells of the inner part of the wood and in the pith. They grow from cell to cell with the greatest ease, boring through even the thick walls of the large vessels. Towards the surface of the wood they begin to accumulate into twisted, brown masses. These increase in the inner layers of the bark, and it may be noticed that whereas the walls of the wood-cells are not materially altered, those of the bast and inner bark are largely destroyed by the dense fungus growth. Immediately under the cork cells of the bark, numerous solid cushions of fungus tissue are formed by the continued branching and intertwining of masses of threads. These become divided by cross walls into rounded or angular cells, whose appearance in section under the microscope is shown in the central part of fig. 1, plate II. Along the margin of these cushions, spores are produced in large numbers as shown in the figure, and, by the continued growth of cushions and spores, the bark is ruptured. Hence each of the ruptured areas on the bark visible in the photograph in Plate I, fig. 1, is lined by a black cushion of the fungus similar to that shown in vertical section in the figure, from the surface of which quantities of spores are set free into the air. The mode of

formation of the spores is shown in fig. 3, and the different shapes assumed by them in fig. 4. *

The spores germinate readily in water, putting out colourless threads from several of the cells into which each spore is divided (fig. 5). These threads branch freely and become divided up into short lengths by cross walls. Infection of the wounds on mulberry branches no doubt takes place as the result of such spores (which are very minute, measuring only from 25 to 40 by from 10 to 18 thousands of a millimetre in diameter) being blown about from the branches of previously attacked trees or from prunings on the ground. The threads penetrate into the wood and there take the appearance shown in fig. 2. Fig. 4, plate IV, shows the microscopic appearance of the threads produced from spores germinated on dead mulberry wood in a moist still atmosphere ; under these conditions the fungus forms a fine white or grey mould-like growth on the surface of the wood. It will be noticed that the side branches show a tendency to fuse by their tips with other branches.

*Treatment.*—In considering the best methods of checking this disease, the two cardinal points to be borne in mind are that the parasite can be found on dead branches and twigs of the mulberry, whether prunings or broken off from any other cause, and that all its characters go to show that it is a wound parasite, attacking healthy trees only through unhealed scars left when branches are removed.

It is a fortunate circumstance that in Kashmir, as in most other parts of India, dead wood of any sort is not left long on the ground, but is promptly gathered for firewood. In the nurseries, however, this is not the case, and here care should be taken that the prunings and all broken twigs are regularly removed and burnt. Excepting for this matter the treatment of the trees in the

* The spores are often divided by vertical as well as by cross-walls, as the figures show. In the genus *Coryneum* the walls are usually transverse only. A few species are, however, already known that have occasional vertical walls (e. g., *Coryneum Notarisianum* Sacc. on oak and birch twigs), and it seems better to refer the mulberry fungus to this genus than to form a new one to receive it.

nurseries leaves nothing to be desired. The young trees are exceptionally strong, and the pruning is such as to secure well-shaped trees, capable of bearing the maximum quantity of leaf if properly treated afterwards. The superfluous wood is removed by clean cuts, which are rapidly healed by the formation of protective wound tissue. Except in the event of unavoidable injury such as that caused by frost in 1906, there appears to be no reason to anticipate a recurrence of the disease in a severe form in the nurseries.

The condition of the trees from which leaf is actually gathered in the silk-producing villages is very different to that of those in the nurseries. They are of all ages and sizes, up to very large old trees preserved, no doubt, by the rule prohibiting the felling of mulberry trees in the Valley. Contrary to what should be the case, the young trees are not, at least in those villages that I visited, giving as much leaf proportionately to their size as the old ones, and neither are giving nearly as much as they should under proper treatment. This is entirely due to the neglect of pruning and to the manner in which the leaf is gathered.

It would be impossible to exaggerate the damage which is caused at present by the clumsy and ruthless treatment of the bearing trees. I should say that it is quite out of the question for the industry to maintain its present extent, much less to increase, unless this matter is more carefully attended to and the care of the trees secured by instruction and stringent regulations.

The pruning of the mulberry tree is little, if at all, less essential than that of the tea bush, where it is considered by many to be the most important individual operation in the tea gardens during the whole season. The objects aimed at are in both cases the same :—to induce the plant to assume a convenient shape, to increase or keep at a high average the yield of leaf, to retain or improve the quality of the leaf, and finally, to maintain these conditions for the longest possible time. In the silk-producing parts of France and Italy pruning is a highly scientific process and is almost universal in one form or another. A full account of the different methods adopted may be found in the "Traité sur le Ver à Soie du Mûrier et sur le Mûrier" by Maillot and

Lambert, published by Masson & Cie., Paris, in 1906. Even where regular pruning is not practised, care is taken to remove all dead wood, withered twigs and such as are useless for good leaf-production.

While there can be no question of the value of pruning, it is necessary to point out that bad pruning is often worse than none at all. The best results will be obtained if the plants are regularly pruned on a definite system from the nursery onwards. This could be quite easily secured in the young trees which have been distributed from the State nurseries, by periodical inspections. The treatment of the older trees is more difficult as they have been allowed to get into a condition from which it would usually be hopeless to expect to secure well-shaped trees. The most that can be done is to attempt to restore their vigour by judicious removal of all weakly shoots and of the less productive wood. What can be done in bad cases is shown in the photographs reproduced in Plate III, which were taken in the nursery under M. Peychaud's charge at Harwan. But the greatest care should be taken to secure clean-cut wounds, and where the axe is used at all, it should be followed by trimming with a sharp knife. The methods followed at Harwan may be taken as a safe guide.

As already mentioned, *Coryneum Mori* can grow on dead mulberry wood on the ground. It is not less common on dead twigs found on the trees, and every such twig left may serve to increase the production of spores and the consequent danger of infection to healthy parts.

The systematic pruning of the trees is called for not only on account of the necessity of removing all dead and weakly twigs and useless wood in view of the manner in which the injurious action of the twig fungus is favoured by their presence, but also because of the improvement in the quality and amount of leaf which it causes. The two photographs reproduced in Plate III show the result of pruning. They were taken from trees of the same variety growing near together and about the same age. The pruned tree is thickly covered with strong leaf-bearing shoots and the leaves are large. It was entirely free from disease. In the

unpruned trees a number of the branches (of which some are visible on the extreme left) have been killed by *Coryneum Mori*; the remainder are scantily furnished with small, ill-nourished leaves. Though the branch system is larger, the total leaf is much less. It is well known that the quality of the leaf has a marked effect on the health of the worms and on the amount and quality of the silk produced. There can be no doubt from a comparison of the photographs that the pruned tree is superior in quality of leaf as in every other respect to the unpruned.

In Europe it is usual to gather the leaves only, whereas in Kashmir branches are taken; it is apparently contended by some that this, in large trees, serves the purpose of pruning. This would probably be the case to a certain extent if the branches were cut with any system and if the cutting were done with reasonable care. As it is, the trees are being directly injured instead of improved in power of leaf-production and in quality of leaf, by the hacking to which they are subjected. Branches thicker than a man's finger are not supposed to be taken, but little attention is paid to this regulation, and it is probably not a useful one if applied indiscriminately. On young trees it does not prevent over-plucking; on old, it leaves much of the useless wood behind. Trees can be seen in most villages in which so much young wood has been removed that the leaf-bearing twigs of the current year's growth spring largely from the trunk or main branches. Such shoots are usually of short growth, bear often small leaves, and never form the basis for a new system of leaf-bearing shoots in the following year. In many comparatively young trees seen, the leaf-bearing shoots were for the most part dead at the tips and for a variable distance back from the tips. This condition, which is known as "dying back," is a common result of defoliation of plants from any cause, such as the attacks of insects or fungi or from frost. Excessive plucking of leaves in tea and mulberry is known to lead to dying back, and an examination of the trees left no doubt that this was the cause here. The very rapid growth of the industry in the last few years is responsible for this state of affairs. The smaller trees, being easily reached, are

stripped of the greater part of their young leaf-bearing wood during the rearing season. The sudden loss of a large proportion of leaf so affects the upward current of water and food material from the soil that the younger tissues of the twigs dry up and die of inanition.

This over-plucking affects chiefly the younger trees, as the older are not so easily denuded. Trees of all ages are, however, injuriously affected by the manner in which the branches are gathered. If the cutting were done with a proper implement so as to secure a clean-cut surface on the part attached to the tree, the wounds would be rapidly occluded and strong young shoots would be thrown out below the point cut. As a matter of fact, clean cuts are the exception rather than the rule, and much of the crop is apparently obtained by the simple method of breaking the twig in the hand, leaving naturally jagged splinters and wounds behind. The parts immediately around and below these wounds rot and die as with any other tree, and the buds just below the portion removed, whence the next season's leaf should come, are often killed outright or injured. Numbers of twigs of the current year's growth may be seen springing from the margins of old ragged wounds, and these bear, as might be expected, small feeble leaves and show a tendency to die back from the tip.

Unoccluded, jagged wounds with dead splinters attached, of just the sort that will most readily allow of infection by a wound parasite, the presence of the latter on dead twigs attached to the trees, numbers of weakly shoots arising from the injured branches, these are the conditions which are common in the mulberries of the silk-worm rearing villages, and which constitute a real danger to the industry. That under favourable conditions the twig fungus is capable of causing great damage, is evident from the experience in the nurseries in 1906. The two years that have intervened may be taken to be years when conditions were against the parasite ; the nurseries have practically escaped, though the losses in the villages are appreciable. Heavy injury to older trees was not reported in 1906, but would not be so likely to attract notice as in the nurseries ; there is no reason to believe, however, that the former

are less liable to injury from this cause than the latter. The reverse is likely to be the case. The great increase in the demand for food for the worms in the past few years has greatly improved the prospects of the parasite finding wounds through which it may gain an entry into the trees. Hence there is a decided possibility that the disease is on the increase, and it would seem advisable to attempt to diminish the annual moderate loss and the risk of periodical heavy losses.

The first requirement is an improvement in the manner of obtaining the crop. As already mentioned, branches, not individual leaves, are gathered. I could not discover any real reason why this is done except that the worms are fed on the floors of the houses instead of on frames, and the presence of branches ensures a certain amount of ventilation from below and enables the worms to mount when about to form cocoons. From the point of view of diminishing risk of infection by *Coryneum Mori* leaf-plucking would be preferable. Frames would not be expensive and the capacity of the rooms would be increased. The relative advantages of the two systems under the conditions prevailing in Kashmir might be more fully inquired into and the change gradually introduced if found suitable.

A good cheap knife for cutting the branches is much needed. Several patterns of pruning implements are used in France and Italy, each with its own advantages. Some are described and figured in Maillot and Lambert's book referred to above. There would be no difficulty in making the simpler forms in Srinagar, probably very cheaply. The cutting implements used in Kashmir in gathering the branches are primitive to a degree and incapable of producing a clean cut.

Every opportunity should be taken of instructing the silk-worm rearers regarding the necessity of removing the branches in as clean a manner as possible, and of trimming the wound where necessary so as to avoid leaving splinters attached to the tree. Clean wounds will heal naturally and rapidly and the danger of infection will be reduced. At the same time the injurious results of over-plucking should be explained.

During the pruning operations special attention should be paid to removing all dead twigs and unproductive or feeble wood. This is a point which is liable to be overlooked, but its importance is great, not alone directly because of the danger from twig disease, but also because such wood is merely a drain on the tree and diminishes the quality of the leaf. The prunings should, of course, be burnt, but this will probably not require any special precautions being taken as they will be removed for fuel as soon as permission is given. In the nurseries this point requires to be attended to.

Once pruning is adopted as a regular practice and the methods of gathering the crop are improved in the manner indicated above, I feel confident that all real danger to the industry from an increase in this disease will disappear.

## Mulberry Leaf-spot.

(*Septoglœum Mori* (Lév.) Briosi & Cavara.)

This disease is extremely common in Europe where it is sometimes called mulberry leaf-rust though caused by a fungus not belonging to the true rusts. It occurs throughout Kashmir, but does not appear to cause much damage except in the moister parts.

It affects chiefly the younger leaves, which become covered with angular spots, pale brown in the centre and surrounded by a dark reddish-brown band (Plate IV, fig. 1). On the upper surface of these spots, and sometimes also on the lower, little raised pustules appear. In moist weather these swell up into rounded blisters of a pale colour from the development of numerous colourless spores. Affected leaves drop off prematurely and are avoided by the worms. In bad cases the reduction in leaf is said to amount to ten per cent. in individual trees, but this is only likely to occur in seasons of exceptional moisture, and even then is not likely to be general.

The spots are caused by a fungus whose filaments penetrate the tissues of the leaf but are limited in growth and affect an area usually not exceeding a quarter of an inch in diameter. After sufficient food has been accumulated from the living cells of the leaf (which are killed and turn brown) the parasite comes to the

surface to form spores. Cushions of dark fungus hyphæ are formed beneath the leaf epidermis, where they are early visible as small raised black dots. On the surface of these the spores appear and burst through the epidermis to be shed into the air (fig. 2, plate IV). The spores (fig. 3) are elongated, colourless, rounded at the ends, divided into segments by three to five cross-walls, and usually curved. They germinate readily in water and new spots are caused by the penetration of threads from germinating spores into the tissues of the leaf.

Treatment would not repay expenses in ordinary mild cases. In the nurseries it might become necessary in the event of a bad attack, when spraying with Bordeaux mixture would probably be effective. Pulling off and burning spotted leaves early in the season would much reduce the spore formation and consequently the spread of the disease from leaf to leaf.

## Mulberry Mildew.

### *Phyllactinia Corylea* (Pers.) Karst.

The mulberry mildew is fairly common in India and occurs also in Japan and Madagascar, but not, it would seem, in Europe. It has hence not been the subject of detailed researches, especially in the direction of treatment, as have the allied vine mildew and other common European mildews. Fortunately the disease does not appear to be ordinarily a serious one in Kashmir. In Madagascar it is said to attack, above all, mulberry trees planted near paddy fields or exposed to winds that have blown across marshy land. The losses are heavy in these cases, and would, no doubt, be equally heavy in India under similar conditions.

The fungus attacks only the leaves. These are covered with a fine white powdery layer over the whole or a part of the under-surface, and are sometimes deformed or stunted, especially if attacked when young. They are not liked by the worms and eventually turn brown and dry up. The parasite differs from the leaf-spot fungus in developing chiefly on the surface of the leaf and only sends short sucker-branches into the air-pores and the air-cavities

lying below ( fig. 5, plate IV ). From these, fine suckers penetrate into the leaf cells and kill their contents which are absorbed as food Instead of being limited in growth as in *Septoglœum Mori*, the threads ramify over the leaf surface for considerable distances and may eventually cover the greater part with their web.

Mulberry Mildew.

From the superficial web short branches stand up vertically into the air. On the top of each of these a single large spore is formed ( fig. 5 ). The spread of the fungus from leaf to leaf is due to these spores breaking off from their stalks and being blown on to

the under surfaces of healthy leaves where they germinate and give rise to a fungus web which sends sucker-branches into the leaf.

A second spore-form is known but has only been found on a small number of leaves. It is produced in little hard reddish black receptacles visible to the naked eye as small, round, shining grains lying on the surface of the old webs ( fig. 6 ). Inside each is a number of thin-walled sacks within which two or three spores are ultimately developed. It is probable that the latter ripen slowly, as mature spores were not found in any of those examined. This spore-form is concerned with the transmission of the fungus from season to season and through periods when food in the shape of living leaves is not available.

Though, as already said, treatment has not been tried, experience with allied diseases enables one to say with fair confidence that sulphur dusting, as practised in the vineyards against vine mildew ( *Oidium* ), is likely to prove successful. Or the leaves may be sprayed with potassium sulphide ( liver of sulphur ) solution, made by dissolving half an ounce of the sulphide in a pint of hot water and making up to one gallon with cold water. This is not likely to be required except in the nurseries, and from what I saw in 1908, is not at present required there.

The mildew is more destructive to young plants than to full-grown trees. Its attacks are likely to be worst in low-lying places and like most mildews damp hanging ground-fogs greatly favour its spread. Hence, in opening new nurseries, the site should be selected so as to avoid these conditions as far as possible. Similarly in planting out the nursery trees in the villages, high ground should be selected in preference to low, particularly in the lower parts of the valley, adjoining the Wular and Dal Lakes.

## Mulberry Trunk-rot.

### *Polyporus hispidus* (Bull.) Fr.

This fungus belongs to the class of the large bracket-fungi which are familiar objects on the trunks of trees and on old logs. It is extremely common on mulberries and was found also attacking

apple, plum and apricot trees in Kashmir. In Europe it is known on these as well as on several other broad-leaved trees.

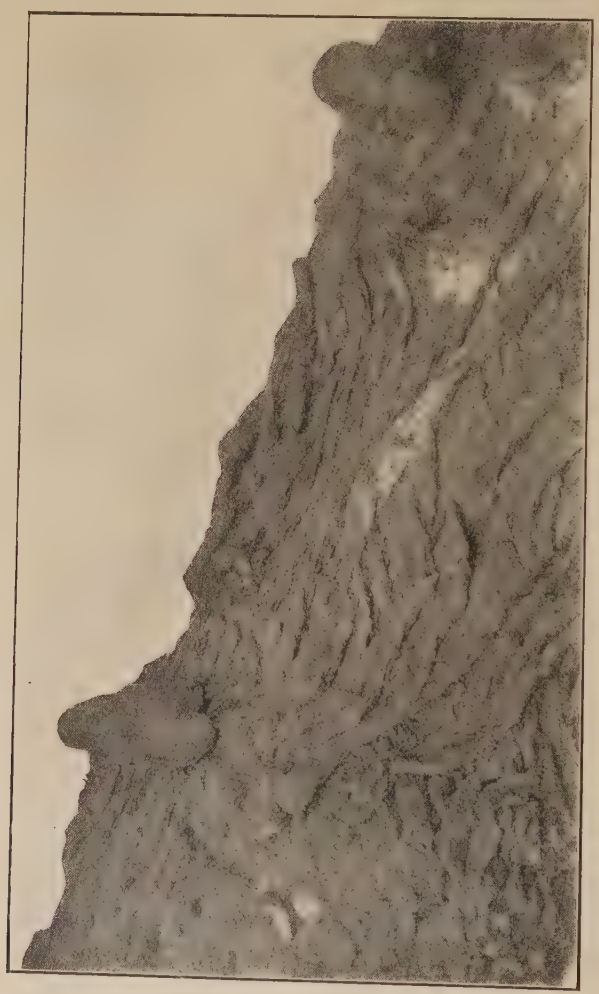
It is found usually on the trunk but also attacks the larger branches. Being a "wound parasite" the infection takes place by means of spores lodging on the scars which are so common on Kashmir mulberries owing to the manner in which the leaf is obtained for silk-worm food. In the scars left by removing large branches a portion of the heart-wood is exposed, and it is here that infection occurs. Scars left by breaking off small twigs which have no heart-wood, are not liable to attack, though, as already mentioned, they are the usual place of entry for the twig-disease fungus.

When the spores germinate, the young threads penetrate into the branch heart-wood and from that to the heart-wood of the trunk, attacking first the central portion and then the outer, younger layers. The tissues are little by little destroyed from within out, becoming soft, spongy and yellowish white. Separating the outer healthy layers of young wood from the rotten central portion, is a hard brown zone, consisting of cells filled with a brown, gummy matter; in this the parasite takes its main development. It is nourished in the brown zone mainly by the cell-contents while the walls are at first left unaltered. Only at a later period, when the cell contents are exhausted, is the wall corroded and the wood itself softened.

Branches attacked by this heart-rot dry up and die. The trunk may be almost completely hollowed, but often a ring of still living wood is left, which is sufficient to keep the crown green. In most cases it is probable that rotted trees are blown down before the parasite can directly cause their death, for while partially rotted and hollow trees are fairly common, few that are obviously near death can be found.

The fungus is perennial within the tree, and about August each year grows out to the surface to form spore-bearing organs. These appear externally on the trunk or main branches, and can be artificially induced to form, by exposing the heart-wood of a part where the threads are numerous, and keeping the wound moist.

The young spore-bearing body is a rounded knob of pale yellow colour, about an inch in diameter, extremely soft and containing a large proportion of water. It is formed of a great number of threads which grow together into a definite shape, forming a smooth mass in which all trace of the component threads is lost, though they are, of course, easily visible under the microscope. The mass now grows into a large, often almost



POLYPORUS HISPIDUS ON THE TRUNK OF A MULBERRY TREE.

hemispherical body attached to the trunk by a broad base and sometimes measuring as much as six inches across The upper

surface becomes strongly convex, the lower less or almost flat. Soon the colour deepens into a characteristic chestnut shade on the top, while the upper surface becomes clothed with thick soft hairs formed of agglutinated threads. At the same time hundreds of small pores are formed on the under surface, and these develop into long yellowish brown tubes, which often exude water in drops while forming, even in dry weather. The body remains soft until quite old when it becomes hard, black, shrunken and cracked. The inner flesh always retains a deep yellowish or almost chestnut brown.

Within the tube, spores are formed in large numbers on special cells which line their walls. Each such cell bears four spores on short stalks. The spores are smooth, single-celled, egg-shaped and brown. They are shed through the tubes into the air. Infection only takes place by means of spores blown from the spore-bodies on the surface of diseased trees.

The remedy consists in cutting out the affected part, when this is a branch, and can be recognised by the presence of the spore-bearing bodies ; in taking care to remove and destroy the latter as soon as they are noticed on the surface ; above all, in endeavouring to reduce chances of infection by removing the branches during pruning or when feeding the worms, in such a manner as to promote rapid healing of the scars. It is noticeable that the fungus is much commoner on mulberries than on apples or plums, and this is undoubtedly due to the abundance of unhealed wounds on the former.

It is probable that the regulation prohibiting the felling of mulberry trees in the Valley is too strictly enforced. There are many old trees hollowed by the action of trunk-rot, which would be better out of the way. They yield leaf of poor quality and bear annual crops of *Polyporus hispidus* which must lead to the infection of neighbouring trees. It would be a comparatively simple matter for the mulberry inspectors to mark such trees, whose removal could then be permitted on condition that they are replaced by a certain number of seedlings.

# DESCRIPTION OF THE PLATES.

## Plate I.

Fig. 1. Base of leading shoot of young tree of *Morus alba*, showing external characters of attack by *Coryneum Mori*. From a photograph.

,, 2. State mulberry nursery, Harwan, Kashmir, with young tree attacked by *Coryneum Mori* in foreground. From a photograph.

,, 3. Branch from a bearing mulberry tree, showing a patch of twig-disease at each scar left by removing side twigs.

## Plate II.

,, 1. Vertical section through a cushion of *Coryneum Mori* in the bark of *Morus alba*. Magnified 125.

,, 2. Portion of a transverse section through the wood of a twig of *Morus alba* attacked by *Coryneum Mori*, showing the fungus threads in the cells and vessels of the wood. Magnified 500.

,, 3. Cells at the surface of a cushion of *Coryneum Mori* bearing spores. Magnified 500.

,, 4. Spores of *Coryneum Mori*. Magnified 500.

,, 5. Germination of the spores of *Coryneum Mori* when sown in water.

## Plate III.

,, 1. Pruned tree of *Morus alba* at Harwan. From a photograph.

,, 2. Unpruned trees of same variety and growing near by. Many of the terminal twigs, especially of the tree to the left, have been killed by *Coryneum Mori*. From a photograph.

## Plate IV.

,, 1. Mulberry leaf-spot (*Septoglœum Mori*) on leaf of *Morus alba*. Natural size.

, 2. Section through a pustule of *Septoglœum Mori* on mulberry leaf. Magnified 333.

,, 3. Spores of *Septoglœum Mori*. Magnified 666.

,, 4. Portion of the aerial growth resulting from the germination of spores of *Coryneum Mori* on the surface of a block of mulberry wood.

,, 5. Section through a mulberry leaf attacked by mildew (*Phyllactinia Corylea*) showing external web sucker-branches penetrating the air-pores, and spore-bearing branches projecting downwards into the air. Magnified 333.

,, 6. Durable spore-receptacle of mulberry mildew. Magnified 70.

# PLATE I.

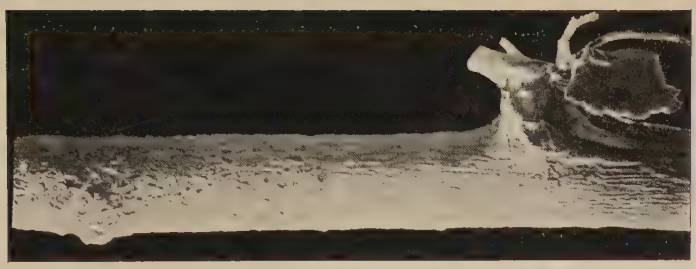


Fig. 1.

Fig. 2.
Coryneum Mori on Morus Alba.

Fig. 3.

PLATE II.

Coryneum Mori Nomura.

# PLATE III.

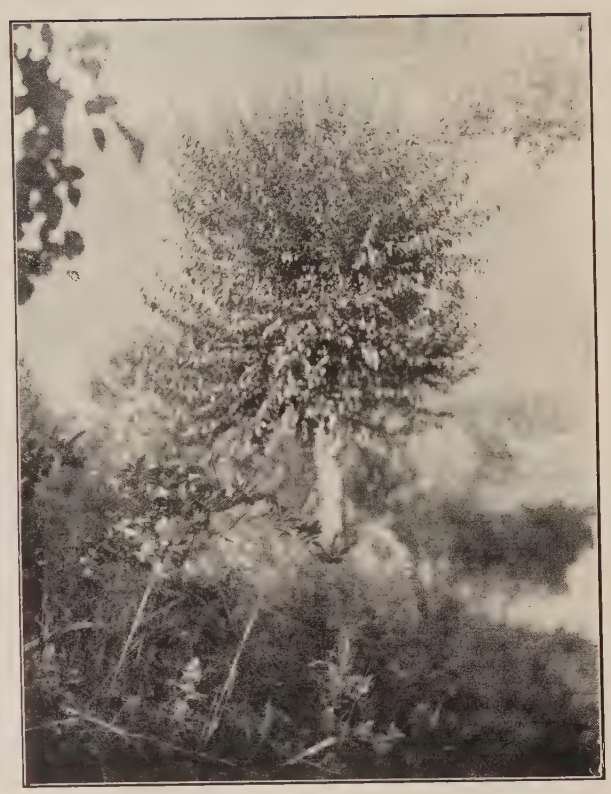


FIG. 1. PRUNED.

FIG. 2. UNPRUNED.

EFFECT OF PRUNING MULBERRY TREES.

PLATE IV.

Septogloeum Mori (Lév.) Briosi & Cavara (figs. 1-3.) Coryneum Mori Nomura (fig. 4.) and Phyllactinia Corylea (Pers.) Karst. (figs. 5-6.)

# PUBLICATIONS OF THE IMPERIAL DEPARTMENT OF AGRICULTURE IN INDIA.

Annual Report of the Imperial Department of Agriculture in India for the year 1904-05. Price, As. 12 or 1*s.* 2*d.*

Report of the Imperial Department of Agriculture in India for the years 1905-06 and 1906-07. Price, As. 6 or 7*d.*

Proceedings of the Board of Agriculture in India held at Pusa on the 6th January 1905 and following days (with Appendices).

Proceedings of the Board of Agriculture in India held at Pusa on the 15th January 1906 and following days (with Appendices). Price, As. 12 or 1*s.* 2*d.*

Proceedings of the Board of Agriculture in India held at Cawnpur on the 18th February 1907 and following days (with Appendices). Price, Re. 1-2 or 1*s.* 6*d.*

Proceedings of the Board of Agriculture in India held at Pusa on the 17th February 1908 and following days (with Appendices). Price, As. 8 or 9*d.*

Standard Curriculum for Provincial Agricultural Colleges as recommended by the Board of Agriculture, 1908. Price, As. 4 or 5*d.*

The "*Agricultural Journal of India.*" [A Quarterly Journal dealing with subjects connected with field and garden crops, economic plants and fruits, soils, manures, methods of cultivation, irrigation, climatic conditions, insect pests, fungus diseases, co-operative credit, agricultural cattle, farm implements and other agricultural matters in India. Illustrations including coloured plates, form a prominent feature of the Journal. It is edited by the Inspector-General of Agriculture in India assisted by an Advisory Committee of the staff of the Agricultural Research Institute, Pusa.] *Annual subscription*, Rs. 6 or 8*s.* Single copy, Rs. 2.

Memoirs of the Department of Agriculture in India. (These are issued from time to time as matter is available, in separate series, such as Chemistry, Botany, Entomology and the like.)

## BOTANICAL SERIES.

| | | |
|---|---|---|
| Vol. I, No. | I. | The Haustorium of the Santalum Album—Early Stages by C. A. BARBER, M.A., F.L.S. Price, Re. 1.<br>Part II.—The Structure of the Mature Haustorium and the Inter-relations between Host and Parasite by C. A. BARBER, M.A., F.L.S. Price, Rs. 3. |
| Vol. I, No. | II. | Indian Wheat Rusts by E. J. BUTLER, M.B., F.L.S., and J. M. HAYMAN. Price, Rs. 3. |
| Vol. I, No. | III. | Fungus Diseases of Sugarcane in Bengal by E. J. BUTLER, M.B., F.L.S. Price, Rs. 3. |
| Vol. I, No. | IV. | Gossypium obtusifolium, Roxburgh, by I. H. BURKILL, M.A. Price, Re. 1. |
| Vol. I, No. | V. | An Account of the Genus Pythium and some Chytridiaceæ by E. J. BUTLER, M.B., F.L.S. Price, Rs. 4-8. |
| Vol. I, No. | VI. | Cephaleuros virescens, Kunze; The Red Rust of Tea by HAROLD H. MANN, D.Sc., and C. M. HUTCHINSON, B.A. Price, Rs. 4. |
| Vol. II, No. | I. | Some Diseases of Cereals caused by Sclerospora Graminicola by E. J. BUTLER, M.B., F.L.S. Price, Re. 1-8. |
| Vol. II, No. | II. | The Indian Cottons by G. A. GAMMIE, F.L.S. Price, Rs. 7-8. |
| Vol. II, No. | III. | Note on a Toxic Substance excreted by the Roots of Plants by F. FLETCHER, M.A., B.Sc. Price, Re. 1-8. |
| Vol. II, No. | IV. | The Haustorium of Olax Scandens by C. A. BARBER, M.A., F.L.S. Price, Rs. 2-8. |
| Vol. II, No. | V. | The Haustorium of Cansjera Rheedii by C. A. BARBER, M.A., F.L.S. Price, Rs. 2-8. |
| Vol. II, No. | VI. | Some Experiments in the Hybridising of Indian Cottons by P. F. Fyson, B.A., F.L.S. Price, Re. 1-8. |
| Vol. II, No. | VII. | The Varietal Characters of Indian Wheats by ALBERT HOWARD, M.A., F.L.S., and GABRIELLE L. C. HOWARD, M.A. (*In the press.*) |
| Vol. II, No. | VIII. | The Mulberry Disease caused by Coryneum Mori Nom. in Kashmir, with Notes on other Mulberry Diseases by E. J. BUTLER, M.B., F.L.S. Price, Re. 1-8. |

## CHEMICAL SERIES.

Vol. I, No. I. The Composition of Indian Rain and Dew by J. WALTER LEATHER, PH.D., F.C.S. Price, Re. 1.

Vol. I, No. II. The Composition of Oil Seeds by J. W. LEATHER, PH.D., F.C.S. Price, Re. 1.

Vol. I, No. III. The Pot-Culture House at the Agricultural Research Institute, Pusa, by J. W. LEATHER, PH.D., F.C.S. Price, Rs. 3.

Vol. I, No. IV. Experiments on the availability of Phosphates and Potash in Soils by J. W. LEATHER, PH.D., F.C.S. Price, Re. 1-8.

Vol. I, No. V. Construction of Drain Gauges at Pusa by M. H. ARNOTT, M.INST.C.E., with a Preface by J. W. LEATHER, PH.D., F.C.S. Price, Rs. 3.

Vol. I, No. VI. The Loss of Water from Soil during Dry Weather by J. WALTER LEATHER, PH.D., F.I.C., F.C.S. Price, Rs. 2.

Vol. I, No. VII. The System Water, Calcium Carbonate, Carbonic Acid by J. WALTER LEATHER, PH.D., F.I.C., etc., and JATINDRA NATH SEN, M.A., F.C.S. (*In the press.*)

## ENTOMOLOGICAL SERIES.

Vol. I, No. I. The Bombay Locust by H. M. LEFROY, M.A., F.E.S., F.Z.S. Price, Rs. 2-8.

Vol. I, No. II. The more important Insects injurious to Indian Agriculture by H. M. LEFROY, M.A., F.E.S., F.Z.S. Price, Rs. 3.

Vol. I, No. III. The Indian Surface Caterpillars of the Genus Agrotis by H. M. LEFROY, M.A., F.E.S., F.Z.S.; and C. C. GHOSH, B.A. Price, Re. 1-8.

Vol. I, No. IV. Individual and Seasonal Variations in Helopeltis Theivora, Waterhouse, with description of a new species of Helopeltis by HAROLD H. MANN, D.Sc. Price, Re. 1.

Vol. I, No. V. The Coccidæ attacking the Tea Plant in India and Ceylon by E. E. GREEN, F.E.S.; and HAROLD H. MANN, D.Sc. Price, Re. 1.

Vol. I, No. VI. The Mustard Sawfly by H. M. LEFROY, M.A., F.E.S., F.Z.S., and C. C. GHOSH, B.A. Price, Re. 1.

Vol. II, No. I. The Rice Bug by H. M. LEFROY, M.A., F.E.S., F.Z.S. Price, Re. 1.

Vol. II, No. II. Remarks on Indian Scale Insects (Coccidæ) by E. E. GREEN, F.E.S., F.Z.S. Price, Re. 1-8.

Vol. II, No. III. The Red Cotton Bug by H. M. LEFROY, M.A., F.E.S., F.Z.S. Price, Re. 1.

Vol. II, No. IV. The Castor Semi-Looper by H. M. LEFROY, M.A., F.E.S., F.Z.S. Price, Rs. 2.

Vol. II, No. V. The Tobacco Caterpillar by H. M. LEFROY, M.A., F.E.S., F.Z.S. Price, Re. 1-8.

Vol. II, No. VI. The Cotton Leaf-Roller by H. M. LEFROY, M.A., F.E.S., F.Z.S. Price, Re. 1-8.

Vol. II, No. VII. Notes on Indian Scale Insects (Coccidæ) by H. MAXWELL LEFROY, M.A., F.E.S., F.Z.S. Price, Rs. 1-8.

## BULLETINS ISSUED BY THE AGRICULTURAL RESEARCH INSTITUTE, PUSA.

No. 1. Notes on Cotton in Behar in 1904, by H. M. LEFROY, M.A., F.E.S., F.Z.S., Imperial Entomologist.

No. 2. An Outbreak of Cotton Pests in the Punjab, 1905, by H. M. LEFROY, M.A., F.E.S., F.Z.S., Imperial Entomologist.

No. 3. The Extension of Jute Cultivation in India by R. S. FINLOW, B.Sc., F.C.S., Jute Specialist to the Government of Eastern Bengal and Assam. Price, As. 12 or 1*s.* 6*d.*

No. 4. First Report on the Fruit Experiments at Pusa by A. HOWARD, M.A. (Cantab.), A.R.C.S. (Lond.), F.C.S., F.L.S., Imperial Economic Botanist. Price, As. 6 or 6*d.*

No. 5. Reports on Trials of the South African Locust Fungus in India by Dr. E. J. BUTLER, M.B., F.L.S., Imperial Mycologist; and H. M. LEFROY, M.A., F.E.S., F.Z.S., Imperial Entomologist. Price, As. 3 or 3*d.*

No. 6. Ticks Infesting Domesticated Animals in India by C. WARBURTON, M.A., Zoologist to the Royal Agricultural Society of England. Price, As. 4 or 6*d.*

No. 7. A Preliminary Account of the Biting Flies of India by H. M. LEFROY, M.A., F.E.S., F.Z.S., Imperial Entomologist. Price, Re. 1 or 1*s.* 6*d.*

No. 8. Official and Recommended Methods for use in Chemical Laboratories of the Department of Agriculture in India by J. WALTER LEATHER, PH.D., F.I.C., F.C.S., Imperial Agricultural Chemist. Price, As. 4 or 6*d.*

No. 9. Report on Cocoanut Palm Disease in Travancore by Dr. E. J. BUTLER, M.B., F.L.S., Imperial Mycologist. Price, As. 6 or 6*d.*

No. 10. Treatment and Observation of Crop Pests on the Pusa Farm by H. M. LEFROY, M.A., F.E.S., F.Z.S., Imperial Entomologist; and C. S. MISRA, B.A. Price, As. 6 or 7*d.*

No. 11. On Flax Dodder by A. HOWARD, M.A., A.R.C.S., F.C.S., F.L.S., Imperial Economic Botanist. Price, As. 4 or 6*d.*

No. 12. The Making and Care of Lawns in India by A. HOWARD, M.A., A.R.C.S., F.C.S., F.L.S., Imperial Economic Botanist. Price, As. 4 or 6*d.*

No. 13. Sugarcane at the Partabgarh Experiment Station by C. CLARKE, F.I.C., Agricultural Chemist, United Provinces; and Khan Bahadur S. M. HADI, M.R.A.C., M.R.A.S., Assistant Director of Agriculture, United Provinces. Price, As. 4 or 6*d.*

No. 14. The Milling and Banking Qualities of Indian Wheats by A. HOWARD, M.A., A.R.C.S., F.C.S., F.L.S., and GABRIELLE L. C. HOWARD, M.D. Price, As. 4 or 6*d.*

## TEXT-BOOKS.

"Indian Insect Pests" by H. M. LEFROY, M.A., F.E.S., F.Z.S. Price, Re. 1-8.

"Indian Insect Life" by H. M. LEFROY, M.A., F.E.S., F.Z.S. 609 pp. Rs. 20. (*In the press.*)